

We claim:

1. A process for the preparation of nanostructured materials in high phase purities comprising:
 - a) mixing a metal containing solution with a precipitating agent to form a mixed solution that precipitates a product;
 - b) passing the mixed solution at elevated pressure and at a velocity into a cavitation chamber, wherein said cavitation chamber has means for creating a cavitation zone and means for controlling said zone, and wherein cavitation of the mixed solution takes place, forming a cavitated precipitated product;
 - c) removing the cavitated precipitated product and the mixed solution from the cavitation chamber;
 - d) separating the cavitated precipitated product from the mixed solution.
2. The process of claim 1 wherein at least some precipitation of the mixed solution occurs in step (b).
3. The process of claim 1 wherein both high shear and at least some in situ calcination of the mixed solution occur in the cavitation chamber.
4. The process of claim 1 wherein the cavitation chamber comprises:
 - a) a flow-through channel having a flow area, internally containing at least one first element that produces a local constriction of the flow area, and having an outlet downstream of the local constriction;
 - b) a second element that produces a second local constriction positioned at the outlet, wherein a cavitation zone is formed immediately after the first element, and an elevated pressure zone is created between the cavitation zone and the second local constriction.

5. The process of claim 4 wherein the velocity of the mixed solution passing into the cavitation chamber is at a velocity sufficient to create cavitation bubbles to form downstream of the first element.
6. The process of claim 5 wherein the cavitation bubbles are formed in the cavitation zone, and the cavitation bubbles collapse in the elevated pressure zone.
7. The process of claim 5 wherein the first element is selected from the group consisting of at least one orifice, a cone, a spherical shaped body, a elliptical shaped body, and at least one baffle.
8. The process of claim 7 wherein the orifice is selected from the group consisting of a orifice having a circular opening and a orifice having a slotted opening.
9. The process of claim 5 wherein the second element is selected from the group consisting of a gate valve, a ball valve, a orifice and a length of the flow channel, wherein the length creates a hydraulic resistance.
10. The process of claim 5 wherein the second element has means for controlling the pressure in the elevated pressure zone.
11. The process of claim 10 wherein the means is a control valve.
12. The process of claim 10 wherein the cavitation zone has a length, and wherein the means for controlling the pressure in the elevated pressure zone additionally controls the length of the cavitation zone.
13. The process of claim 4 having two or more cavitation chambers in series.
14. The process of claim 13 wherein the first element of the succeeding chamber is the second element of the preceding chamber.

15. The process of claim 5 wherein the metal containing solution is a metal salt solution.
16. The process of claim 15 wherein the metal salt is selected from the group consisting of nitrate, acetate, chloride, sulfate, bromide, and mixtures thereof.
17. The process of claim 15 wherein the metal in the metal containing solution is selected from the group consisting of cobalt, molybdenum, bismuth, lanthanum, iron, strontium, titanium, silver, gold, lead, platinum, palladium, yttrium, zirconium, calcium, barium, potassium, chromium, magnesium, copper, zinc, and mixtures thereof.
18. The process of claim 17 wherein the metal in the metal containing solution is selected from the group consisting of cobalt, molybdenum, bismuth, iron, potassium, and mixtures thereof.
19. The process of claim 18 wherein the metals are bismuth and molybdenum.
20. The process of claim 18 wherein the metals are cobalt and molybdenum.
21. The process of claim 17 wherein the metal in the metal containing solution is selected from the group consisting of lanthanum, titanium, gold, lead, platinum palladium, yttrium, zirconium, zinc and mixtures thereof.
22. The process of claim 21 wherein the metal is titanium.
23. The process of claim 21 wherein the metal is gold.
24. The process of claim 17 wherein the metal in the metal containing solution is selected from the group consisting of strontium, lead, yttrium, copper, calcium, barium and mixtures thereof.

25. The process of claim 17 wherein the mixed solution additionally contains a solid support.
26. The process of claim 25 wherein the support is selected from the group consisting of alumina, silica, and titania.
27. The process of claim 5 wherein said mixed solution additionally contains a source of silica and the so formed mixed solution is a zeolite gel.
28. The process of claim 5 wherein said mixed solution of step (c) is recycled to said cavitation chamber.
29. The process of claim 28 wherein the precipitating agent is added to the mixed solution as it is recycled.
30. The process of claim 28 wherein the metal containing solution is added to the mixed solution as it is recycled.
31. The process of claim 17 wherein the cavitated precipitated product is a catalyst.
32. The process of claim 31 wherein the cavitated precipitated product is a catalyst containing at least bismuth and molybdenum.
33. The process of claim 31 wherein the cavitated precipitated product is a catalyst containing at least cobalt and molybdenum.
34. The process of claim 21 wherein the cavitated precipitated product is a piezoelectric.
35. The process of claim 24 wherein the cavitated precipitated product is a superconductor.

36. A process for the preparation of nanostructured materials in high phase purities comprising:
- a) mixing a metal containing solution with a precipitating agent to form a mixed solution that precipitates a product; and
 - b) passing the mixed solution at elevated pressure into a cavitation chamber to create cavitation thereby forming a cavitated precipitated product, said cavitation chamber includes:
 - i) means for creating a cavitation zone, and
 - ii) means for controlling said cavitation zone by providing adjustable back pressure within said cavitation zone.
37. The process of claim 36, wherein at least some precipitation of the mixed solution occurs in step (b).
38. The process of claim 36, wherein both high shear and at least some in situ calcination of the mixed solution occur in the cavitation chamber.
39. The process of claim 36, wherein said means for creating said cavitation zone includes a first element internally situated within a flow-through channel having a flow area wherein said first element produces a local constriction of the flow area, said cavitation zone is formed immediately after said first element.
40. The process of claim 36, wherein said cavitation chamber further comprises means for creating a second cavitation zone to produce a multi-stage process.
41. The process of claim 40, wherein said means for creating said second cavitation zone includes a second element internally situated within said flow-through channel having a second flow area downstream of said first element wherein said second element produces a second local constriction of the second flow area, said second cavitation zone is formed immediately after said second element.

42. The process of claim 41, wherein said means for controlling said cavitation zone is varying the distance between the first and second element to provide adjustable back pressure within said cavitation zone.
43. The process of claim 41, wherein said means for controlling said cavitation zone is the second local constriction produced downstream of said first element thereby providing adjustable back pressure within said cavitation zone.
44. The process of claim 41, wherein said cavitation chamber further comprises means for controlling said second cavitation zone to produce a multi-stage process.
45. The process of claim 44, wherein said means for controlling said second cavitation zone includes a third element internally situated within said flow-through channel downstream of said second element to produce a third local constriction downstream of said second element thereby providing adjustable back pressure within said cavitation zone.
46. The process of claim 39, wherein said means for controlling said cavitation zone includes a second element internally situated within said flow-through channel downstream of said first element to produce a second local constriction thereby providing adjustable back pressure within said cavitation zone.
47. The process of claim 46, wherein said means for controlling said cavitation zone creates an elevated pressure zone between said cavitation zone and said second local constriction.
48. The process of claim 46, wherein said second element is a control valve.

49. A process for the preparation of nanostructured materials in high phase purities comprising:
- a) mixing a metal containing solution with a precipitating agent to form a mixed solution that precipitates a product; and
 - b) passing the mixed solution at elevated pressure and at a velocity into a cavitation chamber to create cavitation thereby forming a cavitated precipitated product, said cavitation chamber includes:
 - i) means for creating a cavitation zone, and
 - ii) means for controlling said cavitation zone by providing back pressure within said cavitation zone.
50. The process of claim 49, wherein at least some precipitation of the mixed solution occurs in step (b).
51. The process of claim 49, wherein both high shear and at least some in situ calcination of the mixed solution occur in the cavitation chamber.
52. The process of claim 49, wherein said means for creating said cavitation zone includes a first element internally situated within a flow-through channel having a flow area wherein said first element produces a local constriction of the flow area, said cavitation zone is formed immediately after said first element.
53. The process of claim 49, wherein the velocity of the mixed solution passing into the cavitation chamber is at a velocity sufficient to create cavitation bubbles to form downstream of the first element.
54. The process of claim 52, wherein said means for controlling includes a second element internally situated within said flow-through channel downstream of said first element to produce a second local constriction thereby providing back pressure within said cavitation zone to create an elevated pressure zone between said cavitation zone and said second local constriction.

- 55. The process of claim 54, wherein the cavitation bubbles are formed in said cavitation zone and the cavitation bubbles collapse in the elevated pressure zone.
- 56. The process of claim 55, wherein the second element provides adjustable back pressure within said cavitation zone to control said elevated pressure zone.
- 57. The process of claim 56, wherein the second element is a control valve.
- 58. The process of claim 49, further comprising a second cavitation chamber situated in series with said cavitation chamber.